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Study on multi-source data integrating standard and 3D cartographic visualization of urban flooding based on CityGML

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Abstract:

Urban flooding refers to the phenomenon of water accumulation in cities due to strong precipitation or continuous precipitation exceeding urban drainage capacity. At present, the problem of urban flooding has become another major urban disease after other urban problems such as crowded people, traffic congestion and environmental pollution (Weiwu W, et al. 2015). In order to better cope with the problem of waterlogging, there are many hydrodynamic models that can accurately simulate the process of pipe network drainage and water accumulation. However, there are currently two limitations that limit the practicality of these hydrodynamic models. First, these models often require a large amount of input data as a support. These data exhibit multi-source, heterogeneity, multi-scale, multi-resolution and other characteristics, which bring great difficulty to data acquisition and processing (Dongdong Z, et al. 2014). Second, the analysis results of the model contain a large amount of waterlogging related information. However, this information is usually represented by simple texts and tables, which is not conducive to interpretation, transmission and visualization. Especially for location-related information, such as flooding points, flow information of various parts of the drainage pipe, water depth in the flooded area, etc., non-interactive two-dimensional maps or tables can cause inconvenience to disaster management and decision-making.

Therefore, a proper data model, respecting the needs of integration of multisource input and output data of waterlogging simulation and analysis and the needs of 3D visualization in front end, is needed. As a matter of fact, what in the last years has proven to be an emerging and effective approach is the adoption of standard-based, integrated semantic 3D virtual city models, which represent an information hub for most of the above-mentioned needs (Agugiaro et al. 2018). In particular, being based on open standards (e.g. on the CityGML standard proposed by the Open Geospatial Consortium), virtual city models firstly reduce the effort in terms of data preparation and provision. Secondly, they offer clear data structures, ontologies and semantics to facilitate data exchange between different domains and applications, and 3D visualization which is essential for crisis management (Herman L, Řezník T, 2015). However, a standardized and omni-comprehensive urban data model covering also the waterlogging domain is still missing. Even CityGML falls partially short when it comes to the definition of specific entities and attributes for waterlogging-related applications.

This study aims to propose an Waterlogging Application Domain Extension (ADE) for CityGML 2.0, which is used to integrate the multi-source input data and the rich waterlogging related information of waterlogging simulation and analysis. In order to achieve the above objectives, the following contents will be investigated:

(1) Analysis of urban hydrodynamic models' function and their data characteristics

Analyze the function of the hydrodynamic model in the city, and explore the source, precision and organizational structure of the input and output data during the simulation and analysis of waterlogging.

(2) Construction of waterlogging data integration model based on CityGML

Based on the CityGML2.0 and its ADE mechanism, we will construct a conceptual model of waterlogging data integration standard, to describe the geometric and spatial structure of urban buildings, vegetation, land-use, underground pipelines, waterlogging related entities, etc. And more information about waterlogging, such as flooding points, drainage network carrying pressure, catchment area, etc., will be integrated into the corresponding fields of the data integration model in a reasonable way to facilitate Internet transmission and visualization.

(3) Interactive 3D visualization method based on the proposed waterlogging ADE

Based on the rich waterlogging-related information in the waterlogging ADE, combined with 3D visualization technology, the 3D dynamic interactive visualization method is explored, in order to provide more intuitive data support for waterlogging disaster management and decision-making.

Through this study, we expect to improve the efficiency and practicability of the current waterlogging simulation and analysis by integrating the waterlogging related data from multi-source based on CityGML. As the result of the research, we intend to develop a prototype system based on the multi-source waterlogging related data integration method proposed in this study. With this standard, we can provide unified and standard data support for the waterlogging model. At the same time, the results of the waterlogging models are automatically integrated into the data set for dynamic 3D visualization.

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